United States General Accounting Office

GAO

Report to the Chairman, Legislation and National Security Subcommittee, Committee on Government Operations, House of Representatives

September 1993

BALLISTIC MISSILE DEFENSE

Strategic Target System Launches from Kauai

GAO/NSIAD-93-270

Accession Number: 4784

Publication Date: Sep 01, 1993

Title: Ballistic Missile Defense: Strategic Target System Launches from Kauai

Personal Author: Hathaway, B.; Spencer, J.K.; Crowl, R.M., et al

Corporate Author Or Publisher: U.S. General Accounting Office, GAO, Washington, DC 20548 Report Number: GAO/NSIAD-93-270

Comments on Document: Report to the Chairman, Legislation and National Security Subcommittee, Committee on Government Operations, House of Representatives

Descriptors, Keywords: Ballistic Missile Defense Target Launch Kauai BMDO STARS USASSDC Hawaii

Pages: 00022

Cataloged Date: Nov 22, 1993

Document Type: HC

Number of Copies In Library: 000001

Record ID: 28419

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-223094

September 13, 1993

The Honorable John Conyers, Jr.
Chairman, Legislation and National
Security Subcommittee
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

This letter presents information you requested on certain aspects of the Ballistic Missile Defense Organization's[1] (BMDO) plans to launch Strategic Target System (STARS) boosters carrying targets and other experiments from Kauai, Hawaii. Specifically, you wanted to know (1) what the cost of the STARS program is, (2) what the cost of a catastrophic failure would be, and (3) whether planned STARS missions could be accomplished from launch sites other than the Kauai site.

Background

STARS is a BMDO program managed by the U.S. Army Space and Strategic Defense Command (SSDC). It began in 1985 in response to concerns that the supply of surplus Minuteman I boosters used to launch targets and other experiments on intercontinental ballistic missile (ICBM) flight trajectories in support of the Strategic Defense Initiative would be depleted by 1988. SSDC tasked Sandia National Laboratories, a Department of Energy laboratory, to develop an alternative launch vehicle using surplus Polaris boosters. Two STARS booster configurations (STARS I and STARS II) have been developed. The first STARS flight, a hardware check-out flight, was successfully launched in February 1993.

Results in Brief

BMDO will have spent about $183.1 million on the STARS program through fiscal year 1993. About $27 million is budgeted for fiscal year 1994. Beginning in fiscal year 1995 when the program becomes operational, project offices that use STARS to launch experiments or targets will pay the estimated $5.9 million for each STARS I launch and $10.9 million for each STARS II launch. In addition to this funding, the STARS project office estimates that it will spend an additional $17 million to $20 million a year to operate the program.

[1]Formerly the Strategic Defense Initiative Organization.

Expenses related to a failed launch would be related primarily to clearing vehicle debris and the effects of any associated fires in the ground hazard area. They would not appear to be extensive, but no cost estimate has been made. SSDC officials have taken actions to contain debris from a failed launch within an established hazard area.

Twelve more STARS launches from Kauai are scheduled through fiscal year 2003—one a year except for two in fiscal years 1995 and 1998 and none in fiscal year 1997.[2] The primary objectives of mission 2 could have been achieved from another location, and the primary objectives of missions 3, 4, 5, and 7 could be achieved from other locations. However, some mission delays and performance degradation would be expected, as well as additional costs for constructing alternative launch sites. Project officials have not seriously studied whether alternative launch sites for mission 6 exist. Missions 8 through 13, which are scheduled to begin in 1998, are system integration tests. Because specific objectives of these tests have not been defined, we could not assess whether alternative launch sites exist.

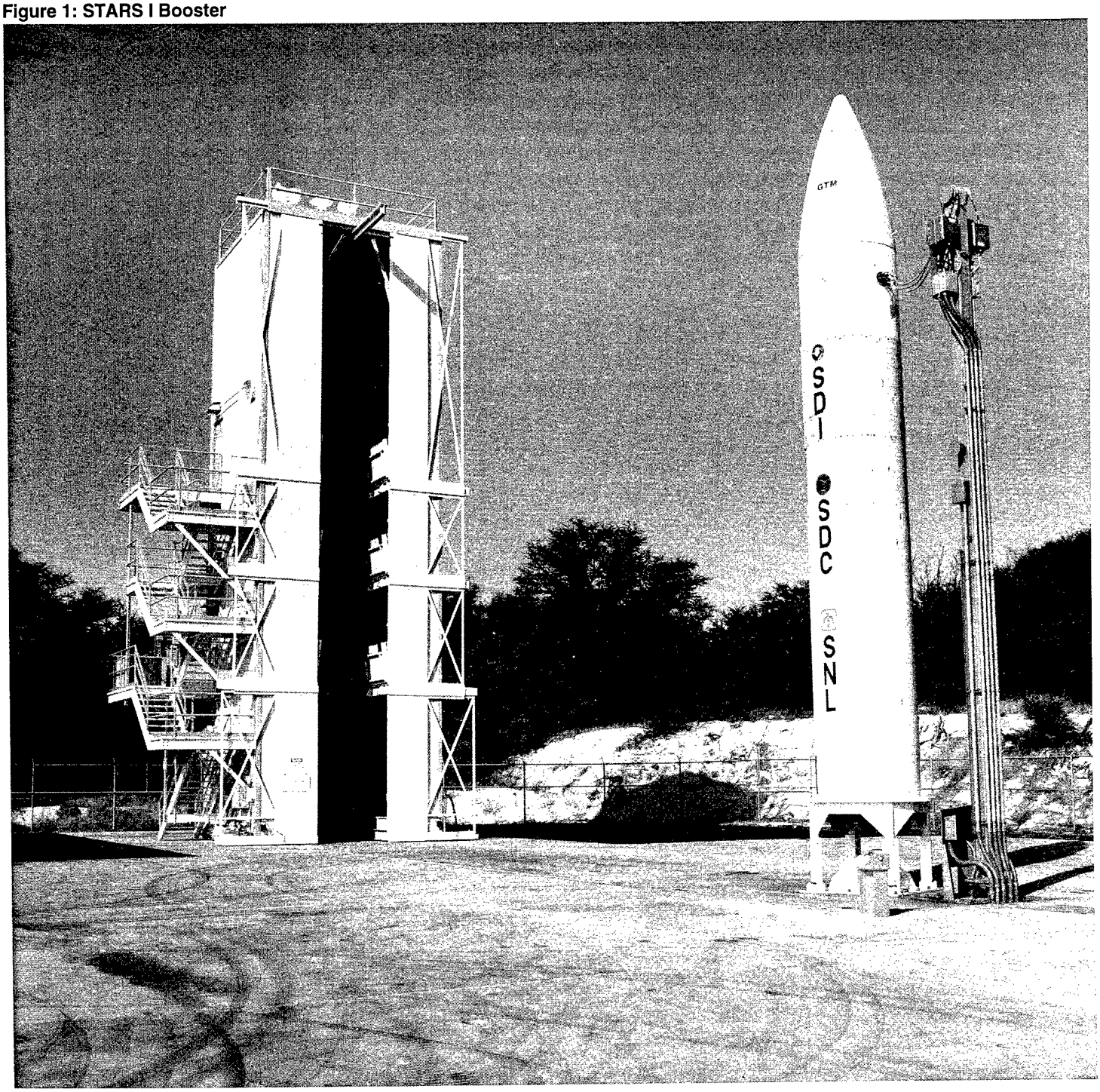
STARS Program

STARS I consists of refurbished Polaris first and second stages and a commercially procured Orbus I third stage. STARS I can deploy single or multiple payloads, but the payloads cannot be deployed in a manner that simulates bussing. To meet this specific need, Sandia developed an Operations and Deployment Experiments Simulator (ODES) post-boost vehicle.[3] When ODES is added to the three STARS I stages, the configuration is designated STARS II. (See figs. 1 and 2 for photographs of the STARS I booster and the ODES structural test unit.)

[2]Mission 2 was successfully launched on August 25, 1993.

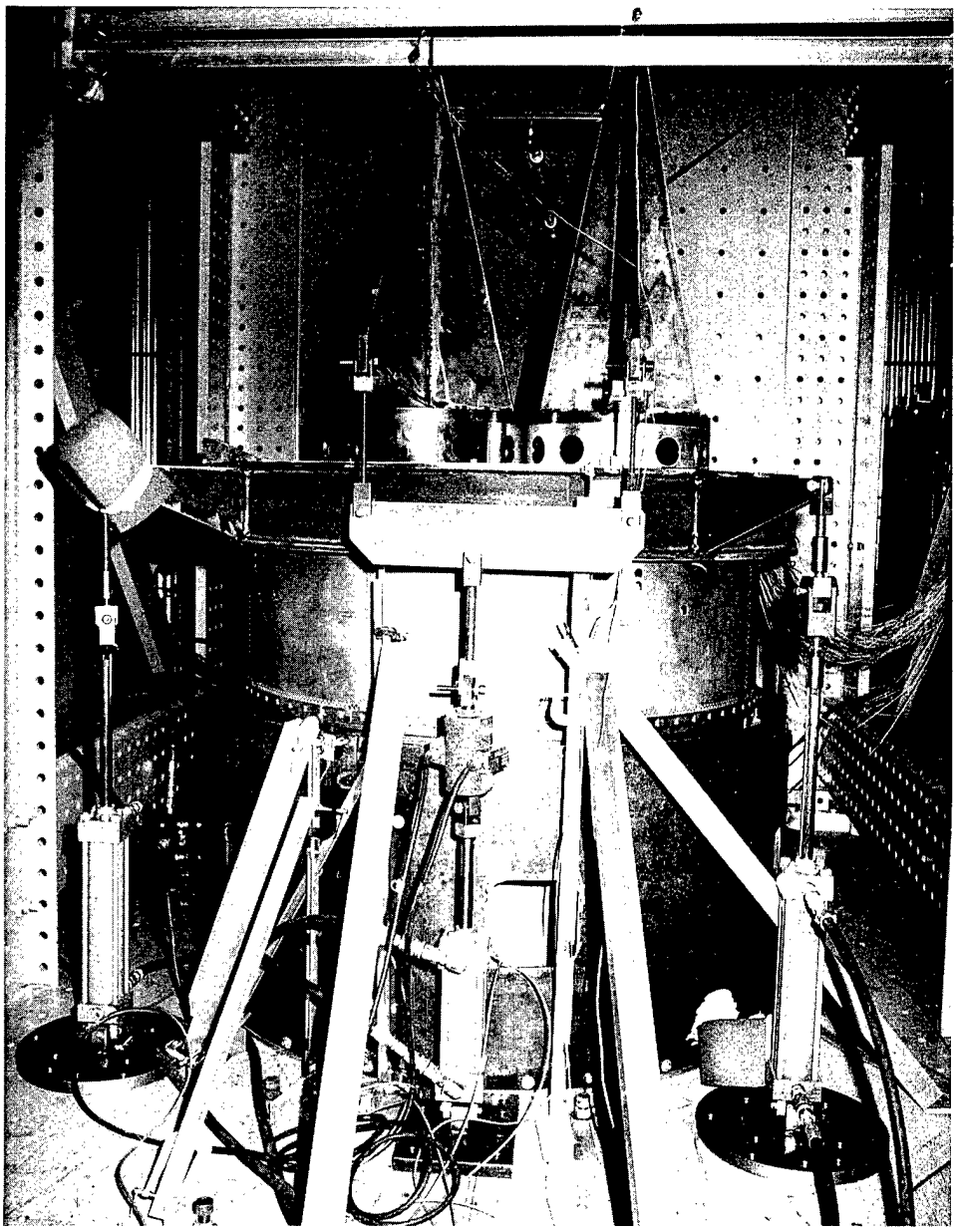
[3]A post-boost vehicle, also referred to as a "bus," is that portion of a missile payload that carries multiple warheads and which has the maneuvering capability to independently target each warhead on a final trajectory toward a target.

Figure 1: STARS I Booster



Source: SSDC.

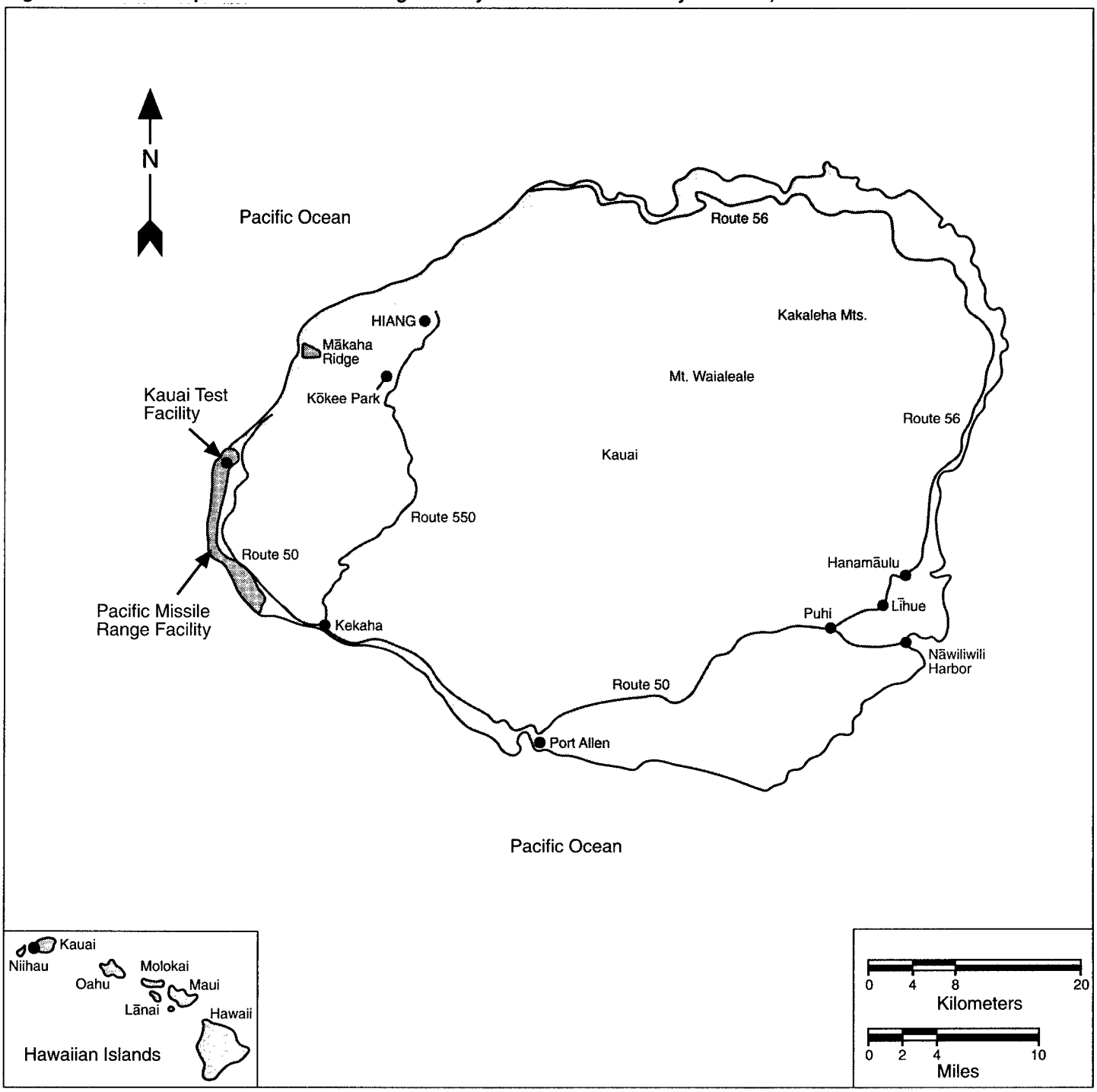
Figure 2: ODES Structural Test Unit



Source: SSDC.

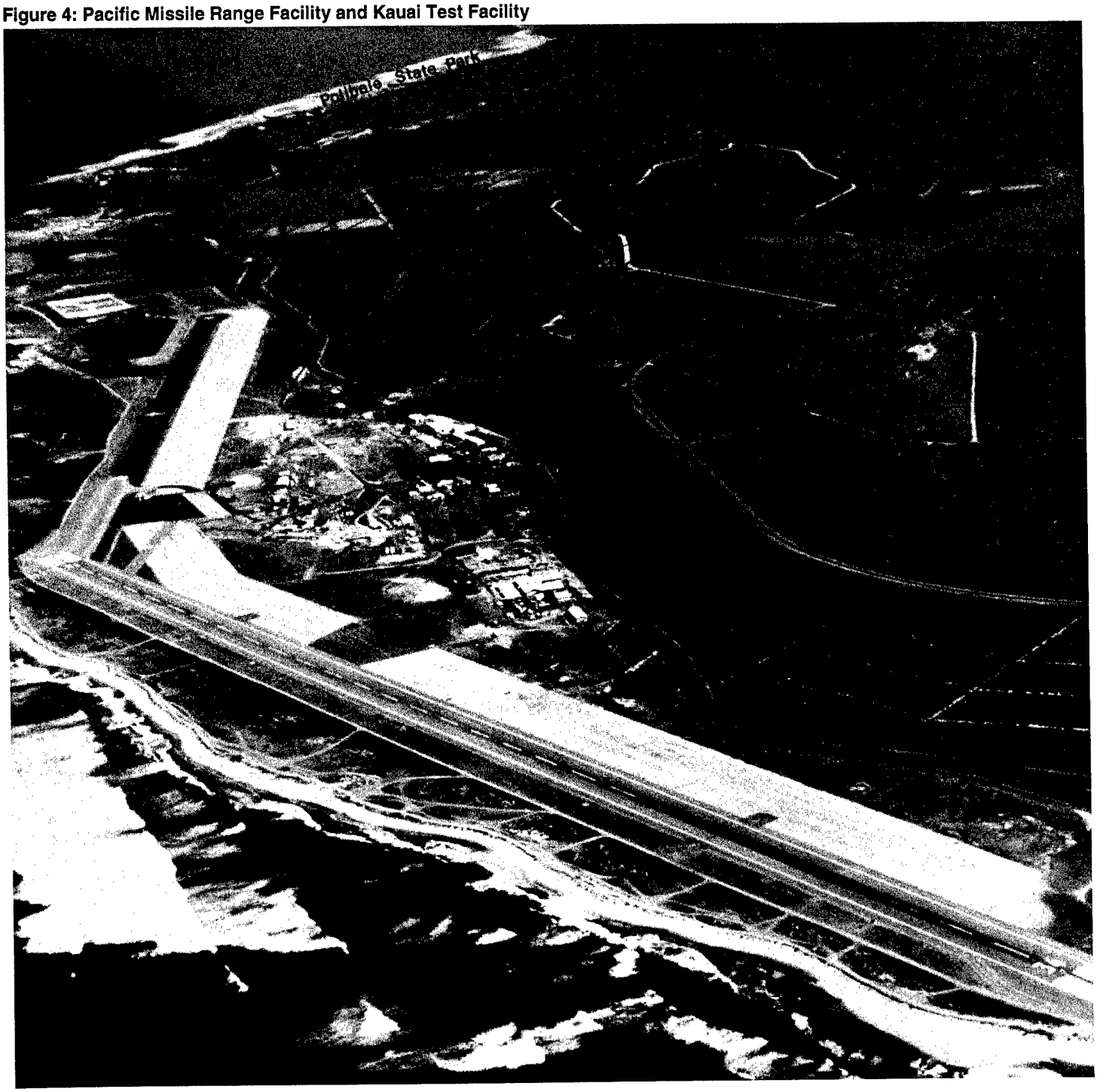
The STARS launch facility is located on Kauai (see figs. 3 and 4). The booster's range, about 2,500 miles, is about the same as the distance from Kauai to the Kwajalein Atoll in the Marshall Islands, the intended destination. Kwajalein, where sensing and other tracking devices are located (see fig. 5), is one of two designated test ranges under the Anti-ballistic Missile Treaty. The other, White Sands Missile Range, is inadequate for the types of tests planned for STARS.

Figure 3: Location Map of Pacific Missile Range Facility and Kauai Test Facility on Kauai, Hawaii



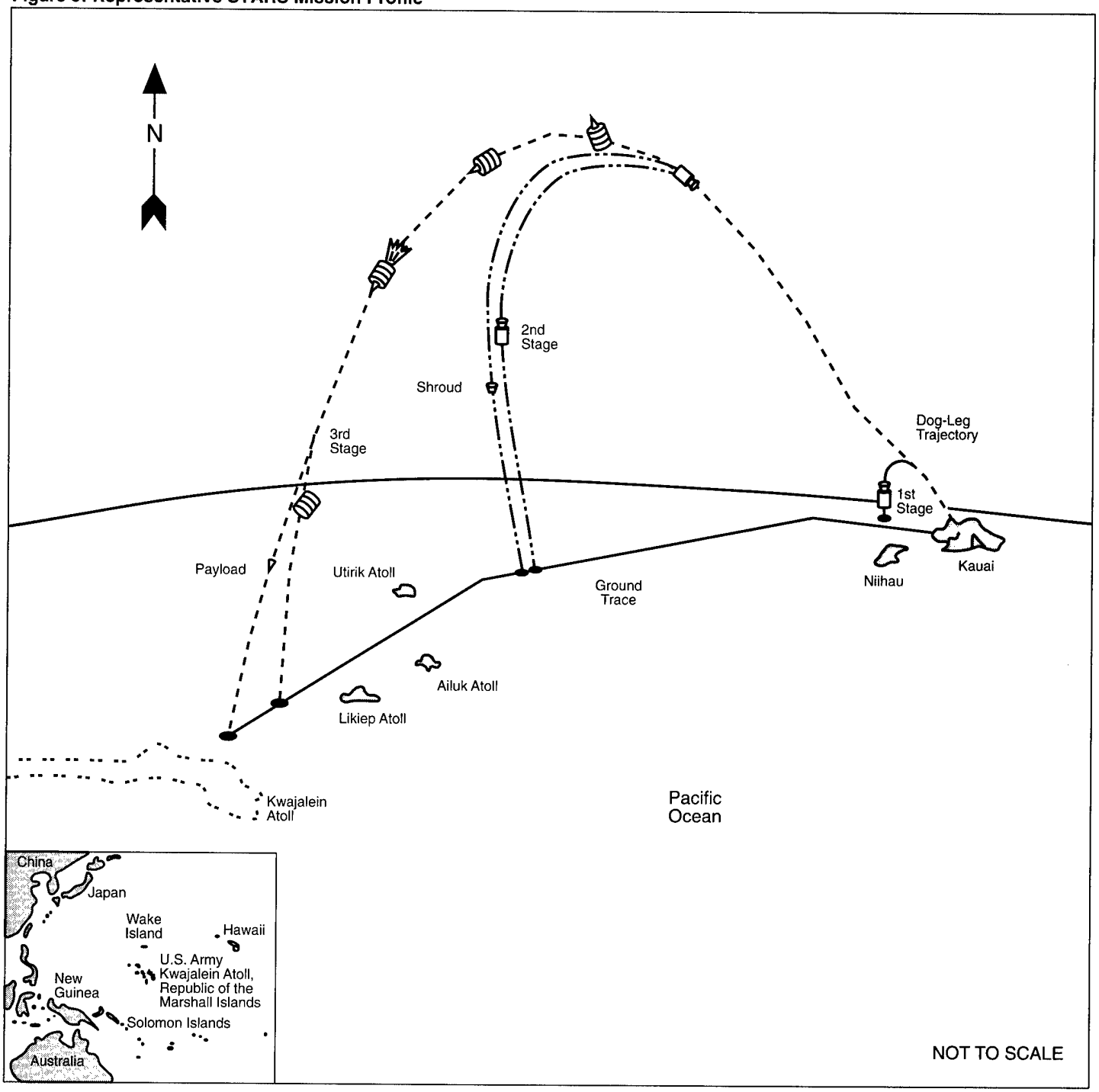
Source: SSDC.

Figure 4: Pacific Missile Range Facility and Kauai Test Facility



Source: SSDC.

Figure 5: Representative STARS Mission Profile



Source: SSDC.

BMDO's plans for launches at Kauai through fiscal year 2003 and the possibility of meeting their primary objectives if launched from other sites, such as Vandenberg, are shown in table 1. All STARS launches through the first quarter of fiscal year 1998 will support efforts related to the development of technology for the planned national missile defense system, primarily the Brilliant Eyes sensor and the ground-based radar. However, data gathered during some experiments will be used to support theater missile defense development. Beginning in fiscal year 1998, STARS will support national missile defense system integration tests. If the schedule for developing a national missile defense system slips, requirements for STARS-launched targets could also slip.

Table 1: STARS Mission Schedule and Feasibility of Achieving Primary Test Objectives at Alternative Launch Sites

	Launch schedule by fiscal year											Primary test objectives could be met at alternative launch sites
Mission	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	
STARS I check-out flight	1[a]											Launched in Feb. 1993
Reentry vehicle experiment	2											Yes, if decision had been made prior to May 1993
ODES check-out flight		3										Yes
Midcourse Space Experiments			4 5									Yes Yes
Ground-based radar				6								Unknown
Brilliant Eyes						7						Yes
System integration tests						8	9	10	11	12	13	Unknown

[a]Numbers shown represent mission numbers.

STARS Program Cost

The STARS program consists of two phases—development and operational. The development phase is expected to cost $183.1 million through fiscal year 1993. About $27 million is requested for fiscal year 1994. The operational phase will begin in 1995, and its annual program expenditures are estimated to be in the $17 million to $20 million range. In addition, BMDO project offices will pay an estimated $5.9 million and $10.9 million to launch experiments on STARS I and II boosters, respectively.

Development Phase Costs

BMDO will have spent $183.1 million to develop STARS by the end of fiscal year 1993 (see table 2). Sandia, with a current staff of about 55 employees assigned to STARS, has received $140.3 million of this amount. About 33 percent of the funds will go to subcontractors, according to Sandia.

Table 2: Funding for Development of STARS

Dollars in millions

	Fiscal year						
Item	**1985-88**	**1989**	**1990**	**1991**	**1992**	**1993**	**Total**
Sandia National Laboratories:							
STARS launch vehicle[a]	$28.1	$13.4	$11.7	$17.6	$16.2	$15.6	$102.6
ODES	3.3	0.2	8.9	7.8	10.9	6.6	37.7
Range development	0	1.8	1.5	6.3	7.9	6.0	23.5
Site construction	5.8	0.4	0	0.6	0	0	6.8
Miscellaneous	0.7	0.2	1.5	3.2	3.4[b]	3.5[b]	12.5
Total[c]	**$38.0**	**$15.9**	**$23.6**	**$35.5**	**$38.4**	**$31.7**	**$183.1**

[a]See table 3 for details.

[b]In fiscal year 1992 the Department of Energy, Sandia's owner, began charging a 3.2 percent surcharge on funds going to Sandia. The amount retained in fiscal year 1992 was $1.1 million, which included a surcharge of about $159 thousand on fiscal year 1991 funds not used until fiscal year 1992. The fiscal year 1993 charge was $0.7 million. These funds are included in the miscellaneous line.

[c]Totals may not add due to rounding.

STARS

Through fiscal year 1993, BMDO has provided $102.6 million to Sandia to develop the launch vehicle (see table 3). The major pieces of the launch vehicle's hardware are

- the retired Polaris first and second stage motors,
- the Orbus third stage motor,
- the electrical and mechanical hardware to integrate the three stages, and
- the guidance and control subsystem.

Table 3: Sandia's Cost for Development of STARS

Dollars in thousands

Item	Fiscal year 1985-88	1989	1990	1991	1992	1993[a]	Total
Funding received from BMDO:							
Funding brought forward	$0	$82	$460	$557	$5,618	$8,442	
Current year funding (see table 1)	28,141	13,364	11,686	17,562	16,205	15,609	$102,567
Total available	**28,141**	**13,446**	**12,146**	**18,119**	**21,823**	**24,051**	**102,567**
Funding spent:							
Project engineering	18,074	6,321	8,429	6,134	2,554	2,128	43,640
Refurbishment of Polaris stages	6,185	4,230	686	958	876	2,014	14,949
Modify STARS for ODES	0	0	11	1,567	3,935	5,210	10,723
Guidance and control subsystem	2,595	1,442	1,393	1,850	660	1,326	9,266
Kwajalein Range support	1,171	888	720	299	1,013	466	4,557
Launch operations	3	0	51	677	1,419	2,372	4,522
Range flight safety	31	105	299	352	371	232	1,390
Operational flight support	0	0	0	664	2,553	3,238	6,455
Total spent	**28,059**	**12,986**	**11,589**	**12,501**	**13,381**	**16,986**	**95,502**
Funding carried forward	**$82**	**$460**	**$557**	**$5,618**	**$8,442**	**$7,065**	**$7,065**

[a]Fiscal year 1993 costs are projected based on costs incurred during the first half of the year.

For project engineering, Sandia used $43.6 million (see table 3). It used $30.6 million in-house to plan and conduct this work, and it paid about $13 million to subcontractors. The following activities were funded:

- Acceptance testing procedures and qualifying all electrical hardware to be integrated into the two booster stages, through a $1.2 million subcontract to Lockheed's Missile and Space Division.
- Development and testing of the third stage Orbus motors through a subcontract for $6.4 million to United Technologies.[4]
- Design and fabrication of (1) ground support equipment, such as manual and automatic test equipment used to verify the system's design and identify and isolate component and system failures for all hardware components except the motors and (2) a launch control computer, which is used to conduct practice and actual launch countdowns.
- Wind tunnel tests on the boosters to verify flight configuration.
- Three ground test missions, one canceled launch, and the first launch in February 1993.

[4]BMDO purchased the Orbus motors with other BMDO funding for about $1 million each.

- Preparation of analyses to support preparing an environmental impact statement.

For refurbishment of retired Polaris missile stages, Sandia used $14.9 million (see table 3). About $6 million was spent in-house and $9 million was paid to subcontractors—$4.8 million to Aerojet and $2.2 million to Hercules to do the refurbishment process for Polaris first and second stage motors, respectively. Under the direction of Sandia, Aerojet and Hercules have refurbished 11 first stage motors and 10 second stage motors. Aerojet and Hercules also designed and built (1) test stands that were used to evaluate motor condition and conduct static firing tests for each stage motor and (2) STARS-unique ground support equipment. Sandia also used Lockheed's Missile and Space Division, the Polaris motor developer and the Navy's designated caretaker for the system, as the consultant for all booster integration testing and problem analysis. Sandia developed, among other ground support equipment, various manual test devices to evaluate first and second stage motor condition.

Sandia used $10.7 million to modify the STARS I configuration to accommodate ODES (see table 3). The funds were primarily spent in-house to design, fabricate, and test all electronic and mechanical interfaces on STARS I that were needed to join it with ODES.

Sandia used about $9.3 million to develop the guidance and control subsystem (see table 3). Of this amount, about $8.1 million was spent in-house to develop, code, and verify guidance and control algorithms and software; design the guidance and control component; and conduct various component and system tests. Component tests included shock and altitude vibration tests of guidance and control flight computers, the inertial measurement unit, and junction and input boxes. System tests were conducted by integrating all components and mounting them on a flight simulation table to test missile pitch, yaw, and roll performance. To conduct component and system tests, Sandia developed special support equipment unique to guidance and control electronics. The balance, about $1.2 million, was spent by the subcontractor, Honeywell, to produce the control system's inertial measurement control and airborne flight computer components.

ODES

BMDO provided $37.7 million through fiscal year 1993 to Sandia to develop ODES (see table 2). These funds will be used primarily for engineering design, analysis, testing, and the production of ODES post-boost vehicle hardware. Sandia's project engineers (1) designed all ODES structural,

electronic, and propulsion components, (2) conducted special studies related to resolving technical problems associated with ODES design, (3) designed payload interfaces for various BMDO user experiments, and (4) planned and conducted analyses related to ODES missions such as developing range safety procedures and mission flight trajectory patterns. Sandia awarded subcontracts totaling about $3.7 million to obtain ODES guidance and control and propulsion related hardware. A contract for $1.2 million was awarded to Honeywell for three inertial measurement units and flight computers, and Advanced Research Development Engineering, Inc., received a $1 million contract for ODES fuel tanks. Sandia awarded contracts for the remaining $1.5 million to a variety of vendors for propulsion related hardware such as regulator valves and flowmeters.

Range Development

BMDO will have spent $23.5 million through fiscal year 1993 for operating test ranges and for upgrading the Pacific Missile Range Facility (see table 2). According to the SSDC manager responsible for the STARS program, about $14.9 million will have been used to operate the Pacific Missile Range Facility (up-range support) and the Kwajalein Missile Range (down-range support) during launch related exercises. These funds supported two ground test missions, a canceled launch, preparation for the initial February 1993 launch, and related mission planning. The remainder (about $8.7 million) will have been used primarily to (1) upgrade the microwave voice transmitters and receivers linking a tracking station to the launch site, which provided an improved in-flight safety analysis capability; (2) upgrade STARS telemetry processing to improve telemetry screen displays for operators to enhance range safety; and (3) augment radar communication at all STARS radar/communication sites to increase data processing capabilities of encrypted ODES missions.

Site Construction

BMDO has spent $6.8 million for construction projects (see table 2). Most of the construction funds were used for two projects—$5.8 million in fiscal year 1987 for launch operations and missile assembly buildings, a missile service tower, and a launch pad at the Kauai Test Facility and $0.6 million in fiscal year 1991 for oxidation, fuel, and decontamination facilities for ODES.

Miscellaneous

BMDO will have spent $12.5 million for various program support activities (see table 2). These funds will have been used primarily for (1) booster transportation and storage at contractor and government facilities during the refurbishment, integration, and launch operation process; (2) studies documenting the environmental impact of STARS launches from Kauai; and

(3) basic project office engineering and technical assistance support contracts.

Operational Phase Costs

Check-out flights of STARS will be completed in fiscal year 1994, and the operational phase of supporting testing will start in fiscal year 1995. SSDC's Strategic Targets Office manager estimates that the annual STARS operational phase budget will be about $17.8 million for fiscal year 1995 and $17 million to $20 million (excluding inflation) for the remainder of the program.

Of the fiscal year 1995 funds, $14.1 million, or about 80 percent, will be used by Sandia to maintain a STARS work force of about 55 engineers and technicians. According to the STARS program manager, this level of staffing is needed even though plans for most years are to only have one STARS launch. The program manager stated that the engineers and technicians will be used to plan for future STARS missions and to conduct hardware fixes of any anomalies noted on completed missions.

The first five ODES flights will use surplus National Aeronautics and Space Administration motors. Then, BMDO plans to begin using a replacement motor that it will develop. It plans to spend about $4.6 million over a 2-year period beginning after fiscal year 1994 to develop the replacement motor; $2.3 million is included in the $17.8 million total for fiscal year 1995.

In addition to the above costs, STARS users will pay an estimated $5.9 million for each STARS I mission and an estimated $10.9 million for each STARS II mission, beginning with the first launch in fiscal year 1995. The STARS I estimate is based on $5 million for hardware refurbishment and procurement (three missile stages and a guidance and control section) and about $0.9 million for Sandia mission support, booster transportation, and government and contractor travel and subsistence. A STARS II mission will cost about $10.9 million, including all costs associated with a STARS I mission plus $5 million for ODES hardware and related integration of ODES with the STARS I. The cost estimates do not include payload and range support costs associated with specific user experiments or the salaries and benefits of the Sandia work force.

Catastrophic Failure Cost

Expenses associated with a failed launch over land have not been estimated but should be limited to the cost of clearing vehicle debris and

the effects of any associated fires in the ground hazard area, which would not appear to be extensive. SSDC officials have taken actions to contain debris from a failed launch within a specified hazard area.

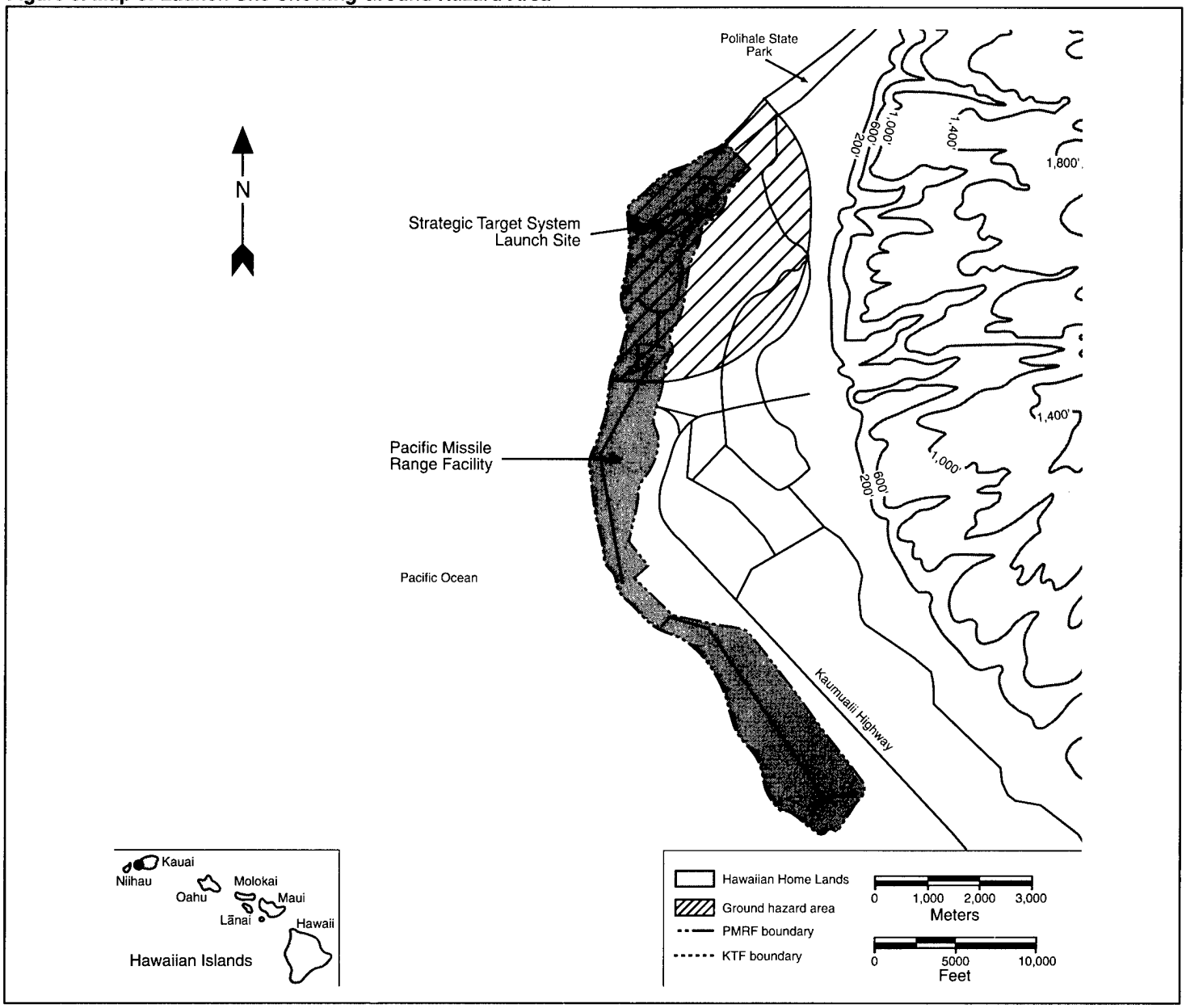
Up to $5.4 million could be spent after fiscal year 1993 to obtain an easement for a 9-year period on land outside the launch facility but within the established ground hazard area. This land is owned by the state, and a memorandum of agreement was negotiated to allow the Navy to clear the area during launches until December 31, 1993. The proposed easement, which would prohibit construction within the area and allow the Navy to control the area during future launches, is being negotiated.

The range safety provisions are contained in a range safety operational plan prepared by the Missile Flight Safety Officer at the Naval Air Warfare Center in Point Mugu, California. This center serves as the lead safety agency for the launch site. The plan establishes hazard areas at the launch site (ground hazard area) and immediately down range of Kauai over the ocean (launch hazard area).[5] The ground hazard area consists of land contained within a modified 10,000 foot radius arc from the launch pad (see fig. 6).

The range safety officer determines boundaries that cannot be violated if debris from a terminated flight is to be contained within the established hazard areas. The plan requires the range safety officer to terminate a launch when the missile's flight path is approaching predetermined limits. To determine if a flight threatens to cross the predetermined flight boundaries, the range safety officer tracks the flight using information from radars, telemetry ground stations, and ground observers. The ground observers, who are in radio contact with the range safety officer, use skyscreens—visual sighting devices containing flight boundary lines—to verify the missile's flight path during the first 25 seconds of flight. To terminate a launch, the range safety officer would send a flight termination signal that would ignite flexible linear-shaped charges placed within the booster.

[5]The launch hazard area is based on the flight path that is used, which for the first mission was 280 degrees. Individual plans for each launch will be prepared that will show a different launch hazard area if a different flight path is planned.

Figure 6: Map of Launch Site Showing Ground Hazard Area



Notes: Kauai Test Facility (KTF).
Pacific Missile Range Facility (PMRF).

Source: SSDC.

STARS Missions and Available Alternatives

The first STARS flight, a hardware check-out flight, was successfully launched in February 1993. BMDO plans to launch 12 more STARS boosters from Kauai that will deliver experiments into near space and targets to Kwajalein through fiscal year 2003. Table 4 provides the schedule by fiscal year for the STARS missions.

Table 4: STARS Mission Schedule

	Fiscal year										
Mission	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
STARS I check-out flight	1										
Reentry vehicle experiment	2										
ODES check-out flight		3									
Midcourse Space Experiments			4 5								
Ground-based radar				6							
Brilliant Eyes						7					
System integration tests						8	9	10	11	12	13

Note: Numbers shown represent mission numbers.

Alternatives to STARS Launches for Missions Two Through Seven

BMDO evaluated alternatives to the proposed STARS launches from Kauai as part of the environmental impact statement prepared in response to local concerns about adverse effects from up to four launches a year over a 10-year period. On June 22, 1992, the BMDO Director decided, based on this evaluation, that BMDO would use the Kauai Test Facility for launching STARS because "the alternative sites and launch vehicles. . .did not meet operational and safety criteria or because they were excluded by treaty limitations."

Subsequently, BMDO's decision to use the Kauai Test Facility was contested by the Sierra Club in the First Circuit Court for the state of Hawaii. It sought to bar Hawaii from entering into an agreement with the Navy that would allow land immediately outside the launch facility to be used as a ground hazard area for STARS launches.

Faced with the prospect of delays while the decision was being contested in court and the possibility of an unfavorable decision that would prevent STARS launches from Kauai, the BMDO deputy director in December 1992 directed that a study be conducted to determine whether missions 1, 3, 4, and 5 could be launched on a STARS booster from elsewhere and the

impacts on the mission of doing so.[6] This study, however, was canceled after the court did not grant a preliminary injunction in a January 25, 1993, decision, and the initial STARS check-out flight was successfully launched in February 1993.

We contacted project officials who are responsible for the missions that were addressed in the study (3, 4, and 5) to determine if the preliminary results indicated if alternative launch sites were available and the impacts on mission objectives, schedule, and cost. We also contacted officials of the projects that were to be supported by missions 2, 6, and 7 to obtain similar information. These officials said that

- the primary objectives, but not all of the other objectives, of missions 3, 4, 5, and 7 could be achieved from alternative sites with some adverse impacts on schedule and cost;
- the objectives of mission 2 could have been achieved from an alternate site had a decision been made to do so before May 1993; and
- the alternative possibilities for mission 6 are unknown because they have not been seriously evaluated. (See table 1.)

Table 5 summarizes these officials' comments regarding program impacts for identified sites and boosters. A more detailed discussion of each mission and possible alternatives is contained in appendix I.

Table 5: Alternatives to Launching From Kauai

Scheduled STARS missions		Alternatives to Kauai launch site					
Through 1998 by mission number	Launch vehicle	Launch vehicle	Launch site location	Use ship-based radar	Mission degradation	Schedule impact	Additional cost
2	STARS-I	MM III	Vandenberg, Calif.	Yes	No	No	No
3	STARS-II	STARS-II	Vandenberg, Calif.	Yes	Yes[a]	Yes	Yes
		STARS-II	Wallops Island, Va.	Yes	Yes[a]	Yes	Yes
		STARS-II	Eastern Test Range, Fla.	Yes	Yes[a]	Yes	Yes
4	STARS-II	STARS-II	Meck Island, Pacific	No	Yes[a]	Yes	Yes
		STARS-II	Vandenberg, Calif.	Yes	Yes[a]	Yes	Yes
5	STARS-II	STARS-II	Meck Island, Pacific	No	Yes[a]	Yes	Yes
		STARS-II	Vandenberg, Calif.	Yes	Yes[a]	Yes	Yes
6	STARS-II	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
7	STARS-II	MM II	Vandenberg, Calif.	Unknown	Yes[a]	Unknown	Unknown
		Firebird	Wallops Island, Va.	Unknown	Yes	Unknown	Unknown

[a] Primary test objective(s) could be accomplished; degradation would occur in secondary and tertiary test objectives.

[6]The mission 2 payload could have been placed on a Minuteman III that was going to be launched from Vandenberg for other purposes.

Specifics were not available regarding mission degradation, schedule, and cost impacts noted in the table, except for mission 2. Program officials estimated it would cost about $3.5 million to place the mission 2 payload on a Minuteman III launched from Vandenberg Air Force Base. However, this additional cost would be more than offset by not launching a STARS booster valued at about $5 million. Also, this is no longer an option because BMDO had to commit to the Minuteman III launch before May 1993. Specifics had not been developed for missions 3, 4, and 5 when the study was canceled. Ground-based radar officials have not seriously evaluated alternative launch sites or vehicles for mission 6. An analysis of mission 7, which was being conducted by the Brilliant Eyes project office, was terminated after the court cleared the way for the first launch in February 1993.

Project officials provided us with the following general comments on radar capabilities, mission degradation, schedule impact, and cost. A ship-based radar would be used instead of the Kwajalein radar for some alternatives. The radar on board the USNS Observation Island is adequate, but it is not as capable in power and sensitivity as the various types of radars on Kwajalein. In addition, Kwajalein facilities can process more telemetry than the ship can. Therefore, some mission degradation would occur. Launches of STARS from an island such as Meck Island near Kwajalein would use the Kwajalein radar, but because of the short distance between the launch island and Kwajalein, the flight trajectory would only allow limited data collection. Construction would be required at alternative STARS launch sites, such as Vandenberg or Meck Island, which would require funding and time to complete.

Alternatives to STARS Launches for Missions Eight Through Thirteen

BMDO plans to use STARS to launch targets from Kauai to Kwajalein to support six of its national missile defense system integration tests—one a year from 1998 through 2003. According to a BMDO official, Minuteman II boosters will be used to launch targets for the other system integration tests. The overall objective of integrated testing is to determine if the system's components—the ground-based interceptor, the ground-based radar, the battle management system, and possibly the Brilliant Eyes sensor—are properly integrated and will function together as designed. The specific objectives of the six tests using STARS-launched targets have not yet been determined by BMDO. Accordingly, we could not assess whether alternatives exist to these planned STARS launches from Kauai that would allow the unspecified missions supported by these launches to be successfully accomplished. The planned schedule for these launches could

slip if an ongoing "bottom-up" review of Department of Defense programs by the Secretary of Defense results in less emphasis being placed on developing and deploying a national missile defense system.

Potential Use of Trident I C4 Boosters for Launching Targets

BMDO is discussing with the Navy the possibility of obtaining Trident I C4 boosters, some of which are being replaced in the fleet with Trident D5s, for use as another integration testing launch vehicle. It is also studying whether the C4 can be modified to carry the STARS bus or whether the C4 bus can be used for deploying targets. The Navy has indicated a willingness to provide enough C4s to more than cover current requirements for bus-deployed targets. The C4 could carry targets from Vandenberg Air Force Base to Kwajalein.

If used as a target launch vehicle, the C4 will be subject to the Strategic Arms Reduction Treaty (START) I because BMDO has determined that electronic telemetry transmitted from the booster's bus to the ground needs to be encrypted for security reasons. Under START I, waivers to the electronic telemetry encryption restriction are provided for up to 11 test missions a year of which no more than 4 test missions may be of a type of ICBM or submarine-launched ballistic missile (SLBM) ever flight-tested with a post-boost vehicle, such as the C4. Additionally, START I limits waivers to the telemetry encryption restriction to no more than two encrypted flights on an existing type (i.e., operationally deployed) ICBM or SLBM, such as the C4. Although the Navy may retire the C4, until all C4 operational missiles are retired and all C4 launchers are eliminated or converted to another SLBM type in accordance with START provisions, BMDO cannot encrypt the telemetry from more than two test missions annually.

According to BMDO officials, STARS is exempted from START I and is also exempted from the START II provision that will prohibit, possibly as early as the year 2000, ICBM flight tests carrying more than one reentry vehicle. STARS is exempted because, for START purposes, STARS is considered to be a booster used only for research and development purposes subject to the 1987 Intermediate-range Nuclear Forces Treaty.

BMDO officials estimated that it could take up to 4 years to develop an alternative launch vehicle to meet its needs and that it would cost $30 million to $40 million. They stated that these estimates were based on data developed during a BMDO study completed in August 1992 and that, although the C4 was not addressed in the study, they thought these rough estimates would apply to a C4 conversion. Regarding the cost estimate,

about 20 percent would be for construction. A study, expected to be completed in September 1993, will estimate the funding required to develop C4s as a target launch vehicle for system integration testing, the time it would take to do so, and the feasibility of using the ODES bus or the C4's bus to deploy targets.

Scope and Methodology

To determine the cost of the STARS program through fiscal year 1993, we obtained funding data generated by the SSDC accounting system and maintained by SSDC project officials. These officials also provided program funding estimates beyond fiscal year 1993. Sandia provided us cost data through fiscal year 1993 that specified, by major program categories, the activities supported by STARS funding.

To determine if missions could be supported with launches from sites other than Kauai, we contacted BMDO test and evaluation officials, SSDC Strategic Targets Office officials, Program Executive Office Missile Defense officials, and BMDO project officials. We reviewed BMDO studies addressing site and launch vehicle alternatives and discussed the performance characteristics of the STARS booster with BMDO and SSDC officials. To determine the availability of C4 missiles for use in the BMDO's test program, we contacted the Navy official responsible for managing the Navy missile inventory.

We discussed treaty restrictions on use of missiles for test purposes with a BMDO START I and II expert. We reviewed the established range safety procedures for STARS launches and discussed range safety matters with the Missile Flight Safety Officer responsible for STARS launches, who is located at the Naval Air Warfare Center, Point Mugu, California.

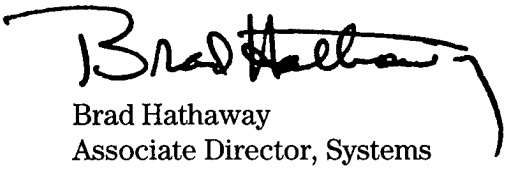
We performed our review at BMDO, Washington, D.C., and at SSDC, Huntsville, Alabama. Our review was conducted from October 1992 to July 1993 in accordance with generally accepted government auditing standards.

As requested, we did not obtain fully coordinated agency comments on a draft of this report. We did, however, discuss the results of our work with SSDC and BMDO officials and have made changes where appropriate. They agreed with the information in this report.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from it issue date. At that time, we will send copies to the Chairmen of the Senate and House Committees on Armed Services and on Appropriations; the Secretaries of Defense, the Air Force, the Army, and the Navy; and the Directors of BMDO and the Office of Management and Budget. Copies will also be made available to others upon request.

If you or your staff have any questions concerning this report, please contact me at (202) 512-4841. The other major contributors to this report are J. Klein Spencer, Assistant Director, and Robert M. Crowl, Evaluator-in-Charge, and Mark A. Lambert, Site Senior, of the Atlanta Regional Office.

Sincerely yours,



Brad Hathaway
Associate Director, Systems
Development and Production Issues

Strategic Target System Scheduled Launches Through First Quarter of Fiscal Year 1998

Mission 2

This mission, which is scheduled for the fourth quarter of fiscal year 1993, will deploy both a U.S. and a British payload.[1] The U.S. mission is to assess the performance of the reentry vehicle and its trajectory during reentry. The experiment will use a radar based at Kwajalein and optical sensors to evaluate various characteristics of the reentry vehicle. Details regarding the British payload are classified. In this experiment the third stage booster will be fired downward in order to achieve reentry speed close to an intercontinental ballistic missile (ICBM) reentry vehicle. The Strategic Target System (STARS) missile will not be encrypted.

According to the mission's program manager, the Ballistic Missile Defense Organization (BMDO) has determined that the mission could be conducted using a different target booster launched from a different location. BMDO obtained, as a contingency, a spot for both U.S. and British payloads on an August 1993 Minuteman III flight from Vandenberg Air Force Base, California, to ensure a launch within the British program's time sensitive schedule. According to the program manager, the mission could be completed using a Minuteman III from Vandenberg without degradation to the mission objectives. It would, however, require ship-based radar support from the USNS Observation Island and cost about $3.5 million to place the payload on a Minuteman III launched from Vandenberg. However, this cost would be more than offset by not launching a STARS booster valued at about $5 million. BMDO said a Minuteman launch would increase the technical risk of the mission because additional testing of the payload modifications to meet Minuteman III launch criteria could not be completed within the time available before launch. This option is no longer available because BMDO had to commit to the Minuteman III launch before May 1993.

Mission 3

This mission is a hardware check-out flight of STARS carrying the Operations and Deployment Experiments Simulator (ODES). ODES is a post-boost vehicle designed to deploy a variety of test objects that replicate representative reentry vehicles. The primary purposes of the mission are to validate the ODES design, demonstrate its performance capabilities, and establish the vehicle as an operational launch system for experimental payloads. A secondary purpose for the initial ODES flight is to deploy a number of test objects to support other BMDO programs. The mission is scheduled for the second quarter of fiscal year 1994.

[1]Mission 2 as successfully launched on August 25, 1993.

According to the STARS product manager, this mission could be conducted from Wallops Island, Virginia; Vandenberg Air Force Base, California; or the Eastern Test Range, Florida. The launch date would be delayed and some additional costs would be incurred if an alternative launch site were used. In addition, radar on board the USNS Observation Island would be required. BMDO will encrypt telemetry from the STARS post-boost vehicle for this mission because, among other reasons, visual images of representative test objects will be electronically transmitted.

Missions 4 and 5

Missions 4 and 5 involve launching two STARS post-boost vehicles that will deploy numerous objects for the previously launched Midcourse Space Experiment (MSX) spacecraft to observe. MSX will be launched into orbit from Vandenberg Air Force Base on a Delta II booster during the second quarter of fiscal year 1995 to conduct a variety of experiments, two of which will involve observing objects deployed from the two post-boost vehicles.

Although the experiments will support work being conducted in a number of areas, the data gathered will primarily support the Brilliant Eyes demonstration and validation program. The program is expected to provide information that will fill gaps in BMDO scientific models, collect phenomenology data that will aid planned BMDO deployment programs in resolving technology problems during their development phases, and address critical discrimination issues for both sensors and interceptors.

The first STARS payload is scheduled to be launched in the second quarter of fiscal year 1995. The MSX spacecraft sensor's will then view the numerous objects deployed on two axes from the post-boost vehicles during day time conditions. The objects will represent various representative targets and deployment techniques. Other air, water, and ground-based sensors will provide trajectory identification and cross-correlation verification.

The second STARS payload is scheduled to be launched in the third quarter of fiscal year 1995. The MSX spacecraft will then view the numerous objects deployed in the same manner as for the earlier experiment, except that the mission will be conducted during night time conditions.

According to the MSX program manager, the MSX's primary mission objectives involving the STARS-launched targets could be accomplished with a STARS vehicle launched from a different location than Kauai. While

the manager considers a STARS/ODES launch from Kauai to Kwajalein as the optimum choice, he stated that the mission could be accomplished using a STARS launch from either Meck Island or Vandenberg Air Force Base. He noted that these alternative launch sites would be more costly and that there would be a schedule delay, but that additional analyses are required to determine the cost and schedule impacts. Launches from Meck Island would result in some mission degradation due to decreased sensor viewing time, but the manager stated that the degradation would not prevent the MSX program from meeting its primary objectives. Launches from Vandenberg would also result in some degradation because ship-based radar on board the USNS Observation Island would be used instead of the Kwajalein radar.

BMDO will encrypt telemetry from the STARS post-boost vehicle for both missions because, among other reasons, visual images of representative test objects will be electronically transmitted.

Mission 6

The ground-based radar program has a requirement for a STARS/ODES-launched target during the third quarter of fiscal year 1996. The mission will allow the radar to track a submarine-launched ballistic missile trajectory target and evaluate the missile's ability to discriminate between representative targets being released from a bus. Unlike the other experiments, the ground-based radar experiment must conclude in the Kwajalein area because that is where the radar being tested will be located. Details regarding the targets are classified.

Radar program officials maintain that a STARS missile launched from Kauai represents the optimum target vehicle because it replicates both a submarine-launched ballistic missile flight trajectory and a type of bussing the system must perform against. The project manager stated that the radar project office has not seriously evaluated possible alternative launch sites or vehicles and does not plan to conduct such an assessment unless the STARS program continues to experience delays. He insisted that Kauai or another launch site that will provide the required submarine launched ballistic missile trajectory is needed. Because of the classified nature of the discrimination portion of the mission, telemetry will be encrypted.

Mission 7

The Brilliant Eyes program plans to use a STARS II missile to support a scheduled first quarter fiscal year 1998 demonstration flight test. The Brilliant Eyes program manager began assessing alternatives to a STARS

launch from Kauai in case STARS was not available. He stated that if STARS were unavailable, the Brilliant Eyes experiment could use either a Firebird missile launched from Wallops Island, Virginia, or a Minuteman II launched from Vandenberg Air Force Base, California. In his opinion, the primary mission objectives could probably be accomplished using a Minuteman II launch vehicle. He added that the Firebird's performance would be marginal and that without additional study, it was not possible to comment on whether the primary mission objectives could be accomplished using it as a launch vehicle. The alternatives analysis was terminated when the Hawaii state court allowed the state to enter into an agreement with the Navy for clearance of the ground hazard area, thus permitting the launch of STARS from Kauai.

The manager also noted that since the program is in the early development phase, BMDO could decide to delete the requirement for a STARS-launched target. BMDO expects to complete, by October 1993, its review of contractor test plans delivered in July 1993. These plans could suggest the need to test against targets launched from boosters other than STARS. If BMDO concurs, the mission could be deleted.